

PLANT ITEM MATERIAL SELECTION DATA SHEET

HOP-SCB-00001/2 (HLW)

Melter 1 & 2 Submerged Bed Scrubber (SBS)

- Design Temperature (°F)(max/min): 237/41*
- Design Pressure (psig) (max/min): 15/-3.6
- Location: incell

ISSUED BY
RPP-WIP PDC
4/21/04
INIT DATE

* To consider upset conditions, the top head cover & top head flange shall be designed to 1250°F and 945° respectively.

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Operating conditions are as stated on sheet 5

Options Considered:

- Vessel is operating at pH 3 at the normal operating temperature.
- Vessel is at pH 3 at the maximum operating temperature, 140°F.
- The process conditions for Melter 2 are identical to those for Melter 1. Therefore, it is assumed that the conditions stated on attached Material Selection Data Sheet for HOP-SCB-00001 are applicable to HOP-SCB-00002 as well.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64		X
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N06022

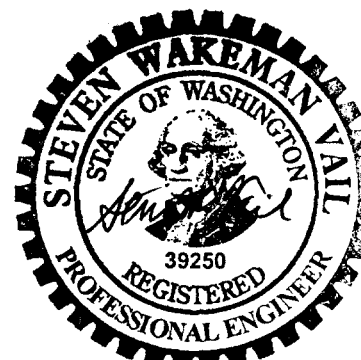
Packing can be an acid resistant ceramic such as Al₂O₃ or equivalent.

Recommended Corrosion Allowance: 0.08 inch

Process & Operations Limitations:

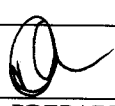
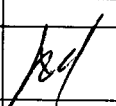
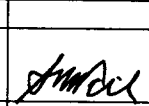
- Develop flushing/rinsing procedure for acid and water.
- Develop lay-up strategy.

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EXPIRES: 12/07/05

This bound document contains a total of 5 sheets.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

It is assumed that upset conditions will be sufficiently infrequent as to not affect the corrosion behavior of the vessel to any significant degree.

a General Corrosion

Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++} . Additionally, Sedriks (1996) has noted with 10% ($\approx 2N$) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy; C-22 has a corrosion rate of about 75 mpy. The presence of Al^{+++} at the forecast ratio of Al/F can reduce the corrosion rate to near zero, but there are regions in the system where there could be excess fluoride. Consequently, a more corrosion resistant alloy such as Hastelloy C-22 will be required.

The dissolution rate of the ceramic components in the proposed environment is unknown. However, data from Clark and Zito (1992) suggest Al_2O_3 , SiC, and ZrO_2 ceramics will have little reactivity in the proposed solutions. The effect of fluoride and the varying temperatures is unclear but the uniform corrosion rate is expected to be larger.

Conclusion: Hastelloy C-22 or the equivalent is recommended to protect the regions in the scrubber that are exposed to excessive temperatures and concentrations. Added protection by using a 0.08 inch corrosion allowance is recommended. A high-fired alumina, silicon carbide (reaction bonded and with no free silicon), or zirconia are expected to be suitably resistant for the packing.

b Pitting Corrosion

Chloride is known to cause pitting of stainless steels and related alloys in acid and neutral solutions. Normally the vessel is to operate at 122°F at a pH of 3. Extrapolating from Wilding & Paige data (1976), it appears that 304L would not pit due to the presence of the nitric acid and excess nitrate. Berhardsson et al (1981) provide similar conclusions. However, the temperature could approach boiling and, in some locations, be superheated. Data from Phull et al (2000) imply that with these conditions, Hastelloy C-22 or equivalent will be needed as a minimum.

Further, if the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain. Pitting is less likely for the higher alloys such as C-22.

Conclusion:

Hastelloy C-22 or equivalent is recommended.

c End Grain Corrosion

End grain corrosion only occurs in concentrated acid conditions.

Conclusion:

Not believed likely in this system.

d Stress Corrosion Cracking

The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, the environment, and because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. For the proposed conditions, Hastelloy C-22 or equivalent is required because of its greater resistance to SCC.

Conclusion:

Because of the normal operating environment as well as that which can occur during off normal conditions, the minimum alloy recommended is Hastelloy C-22.

e Crevice Corrosion

See Pitting.

Conclusion:

See Pitting

f Corrosion at Welds

Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:

Weld corrosion is not considered a problem.

g Microbiologically Induced Corrosion (MIC)

The proposed operating conditions are not conducive to microbial growth. The average operating temperature is approximately correct, but the pH is too low. Further, the system is downstream of the main entry points of microbes and the air streams are heated to over 500°F.

Conclusion:

MIC is not considered a problem.

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h Fatigue/Corrosion Fatigue

Corrosion fatigue is not expected to be a concern. The pressures encountered are so low and the strength of the material is so comparatively high that corrosion fatigue is not a problem.

Conclusions

Not expected to be of concern.

i Vapor Phase Corrosion

The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is suspected the region will be sufficiently washed to prevent solids deposits. C-22 is sufficiently resistant that no corrosion is expected in the vapor space.

Conclusion:

Not expected to be of concern.

j Erosion

Velocities within the vessel are unknown but are expected to be low.

Conclusion:

Not expected to be of concern.

k Galling of Moving Surfaces

Not applicable.

Conclusion:

Not applicable.

l Fretting/Wear

No metal/metal contacting surfaces expected.

Conclusion:

Not expected to be of concern.

m Galvanic Corrosion

No dissimilar metals are present.

Conclusion:

Not expected to be of concern.

n Cavitation

None expected.

Conclusion:

Not expected to be of concern.

o Creep

The temperatures are too low to be a concern.

Conclusion:

Not applicable.

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References:

1. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
2. Clark, DE & BK Zaitos (Editors), 1992, *Corrosion of Glass, Ceramics and Ceramic Superconductors*, Noyes Publications, Park Ridge, NJ 07656
3. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
4. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
5. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

Bibliography:

1. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
3. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Hammer, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
7. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

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OPERATING CONDITIONS

Material Selection Data Sheets for the
HLW Vitrification Facility

Materials Selection Data

Component (Name/ID) HLW SBS HOP-SCB-00001/2
 System HLW-HOP

Operations						
Chemicals	Unit	Cold Startup	Normal Operation*	Contract Max.	Cleaning	Accident
		Note 1		Note 2	Note 3	
Aluminum	g/l		0.22			
Chloride	g/l		0.12	0.27		
Fluoride	g/l		0.17	1.3		
Hydroxide	g/l		0			
Iron	g/l					
Nitrate	g/l		2.2			
Nitrite	g/l		2.9E-05			
Phosphate	g/l					
TOC [†]	g/l		6.4E-06			
Sulfate	g/l		0.61			
Undissolved solids	g/l		3			
Particle size/hardness	µm (##)					
Other (Na, etc)	g/l		1.5	2.73 (Hg ⁺⁺)		
Carbonate	g/l		0			
pH	-		3			
Dose rate, α, β/γ	Bq/L**		3.0E+6, 1.3E+10			
Temperature	°F		122			149 (Note 5)
Velocity	fps					
Vibration						
Time of exposure	#					

* Based on Stream #HV216

- % of total; ## - use Mho scale

Notes:

Note 1: Same as normal operations minus radionuclides and dose rate:

Note 2: Max. contract value mass balance, unreleased. Only values significantly different than normal operations are listed

Note 3: Can be Process H₂O or ≤ 12.2 M HNO₃ for 1 week every 5 years at temperature ≤ 212F, solids being flushed are projected to have compositions of dried melter feed and non routine flush of hot 19M NaOH may slightly dissolve SBS media.

Note 4: deleted

Note 5: Based on the maximum SBS operating temperature (122F) + 27F allowance or off normal event involving SBS cooling or steam ejector use.

[†] List expected organic species:

Use maximum of 2 significant figures